Early Pragmatics in Deaf and Hard of Hearing Infants

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abstract

BACKGROUND AND OBJECTIVES: A set of important pragmatic skills emerge during infancy and pave the way for later language learning. It is thought these early social communication skills develop through infant–caregiver interaction. In a microanalysis, we tested whether deaf and hard of hearing (DHH) infants (typically at high risk of reduced access to rich communicative interaction in infancy) are less likely to engage in gestural and vocal pragmatic behaviors.

METHODS: We coded the naturalistic communication of 8 DHH infants who had no additional needs, who were not preterm or low birth weight, whose parents were hearing, monolingual English speakers, and who had spoken English as their primary target language. The frequency of use of 5 types of infant communication known to positively predict later language development (show gestures, give gestures, index-finger pointing, communicative vocalizations, and early word use) was compared with that of 8 typically hearing infants matched for age, sex, and socioeconomic status.

RESULTS: Hearing loss had a significant negative effect on the frequency with which infants engaged in all types of early communication that predict later language development.

CONCLUSIONS: DHH infants are at high risk of delay in the gestural and vocal communicative skills that lay the foundations for later language. Delay in the gestural domain suggests this is not simply a consequence of difficulties in imitating auditory stimuli. There is significant potential to lift DHH infants onto a positive developmental trajectory by supporting caregivers to nurture interaction from the first year.

WHAT'S KNOWN ON THIS SUBJECT: How often typically hearing infants engage in pragmatic behaviors (like pointing) predicts language development. These early skills are thought to develop through interaction, but evidence is mixed regarding whether deaf and hard of hearing infants show early pragmatic delay.

WHAT THIS STUDY ADDS: Deaf and hard of hearing infants aged 12 to 18 months engage less frequently than matched, typically hearing peers in early gestural and vocal communicative behaviors that predict later spoken language. Caregivers need support from infancy to nurture pragmatic development.

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Dr Kelly designed the study, reviewed the literature, collected the data, adapted the coding scheme, led coding, and cowrote and revised the initial manuscript; Dr Bannard conducted the statistical analyses and critically reviewed and revised the manuscript; Prof Morgan critically reviewed and revised the manuscript; Dr Matthews conceptualized and designed the study, supervised data collection and analysis, acquired funding, and cowrote and revised the initial manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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The development of early pragmatic (ie, social communicative) skills during infancy paves the way for later language.[1,2] These skills are thought to emerge in the context of infant–caregiver interaction, during which caregivers intuitively scaffold communicative development.[3] For example, hearing parents intuitively respond to their infants using speech and vocal cues (eg, gasps and exclamations to indicate interest), and, by 5 months, typically hearing infants come to expect a vocal response to their babble.[4] Furthermore, fluent signing deaf parents intuitively use visual-tactile strategies during interaction to indicate interest and support visual perception of language, and, by 24 months, deaf and hard of hearing (DHH) infants of fluent signing deaf parents have learned to look to their caregivers' faces more often than infants from hearing dyads do.[5,6] However, ~95% of DHH children are born to hearing parents,[7] who typically are not fluent sign language users, have little to no experience communicating with a DHH infant, and, for the majority of families, have spoken language as the goal for their child (typically, providing an oral, sign-supported, or sign-spoken bilingual environment[8]).

Hearing parents with a DHH infant often find scaffolding communicative development challenging, whether targeting a spoken language, a signed language, or both. When learning a signed language, hearing parents can struggle with fluency and the adaptations necessary to support their DHH infant's visual perception of language.[9–12] When supporting development of a spoken language (with or without signed support), ensuring access to communication is often not immediately intuitive.[9,13] Professional support for families to meet these challenges is highly variable,[14] as is social support[15,16] and parents' belief in their ability to support their child's communicative development (ie, feelings of self-efficacy).[17,18] Because of reduced access to language as well as the impact hearing loss can have on the quality of communicative interactions, delays in communicative development and later language learning are found in the majority of DHH infants.[8,19,20] To date, however, it is unclear whether delays emerge in social communication during infancy; current evidence regarding delays in the key early communicative behaviors that pave the way for language development is sparse and equivocal.[21,22]

THE RELATIONSHIP BETWEEN EARLY PRAGMATIC SKILLS AND LATER LANGUAGE DEVELOPMENT

In recent research with typically developing, typically hearing infants, researchers have identified specific early communicative behaviors as being theoretically important indicators of readiness for language learning and good empirical predictors of later language development.[2,23–27] Positive predictors include the frequency with which infants produce give gestures, show gestures, index-finger pointing, and communicative vocalizations (operationalized as vocalizations made within 1 second of looking to the caregiver's face). Alongside first words, these behaviors are thought to be positive predictors because they indicate social-cognitive readiness for language development, and because they elicit timely and informative caregiver responses, which are known to scaffold further development.[28–32] The positive predictive value of these early communicative acts seems to be specific to these behaviors. Indeed, the frequency with which infants rely on some other gestures (eg, open-hand pointing) is a negative predictor of language development.[25,27] Thus, when assessing early pragmatic development in DHH infants, it has become apparent that investigating precise frequencies of specific infant naturalistic behaviors is important.

THE COMMUNICATION OF DHH INFANTS: CURRENT KNOWLEDGE

Relatively little is known about how hearing loss affects social communication in the first 2 years of life. There is evidence that DHH 22 month olds have difficulty in maintaining joint attention (a state arising when caregiver and infant are mutually aware of sharing attention to the same thing).[19,33–35] However, in research with younger infants to date, it has been suggested that DHH infants communicate with their hearing parents at a broadly similar rate to their typically hearing peers,[21,36,37] albeit with some evidence of a reduced frequency of gesture use.[22] A limitation of these studies is that researchers have collapsed across a broad range of behaviors (likely including both positive and negative predictors of spoken language in one count) or have employed binary measures of whether a behavior is in repertoire, rather than measuring the frequency with which that behavior is used for communication. It is the latter that is known to predict outcomes.[27] Moreover, although DHH infants' vocalizations have been explored in terms of their phonology (with evidence of delay[38,39]), there has been little study of the communicative use of vocalizations (regardless of phonological properties). It has recently been found that one of the most valuable predictors of typically hearing infants' transition to speech is the frequency with which they produce communicative vocalizations that are then responded to by the caregiver with language that is relevant to the infant's focus of attention. An infant who benefits from such interactions with a frequency 1 SD above the mean at 12 months is predicted to produce ~28 more words than the average infant by 19 months.[27]

THE CURRENT STUDY

Motivated by the evidence for the predictive value of specific early pragmatic indicators for later language development and the gap in knowledge about the development of these skills in DHH infants, we used a fine-grained coding scheme to measure the early naturalistic communication of DHH infants. We hypothesized that DHH infants who are at risk of reduced access to communicative interaction (in this case, those with hearing parents whose target primary language was spoken English) would engage less frequently than closely matched, typically hearing infants in the communicative behaviors that are positive predictors of spoken language development. If such differences are observed, this would (1) provide health care professionals with a more complete picture of the developmental trajectory of DHH infants' early pragmatic skills and (2) suggest a need to start targeted support of pragmatic development during the first year of life.

METHOD

Participants

Participants were 8 DHH infants, 8 typically hearing infants, and their primary caregivers. The DHH infants were recruited across England and Scotland through the United Kingdom's National Deaf Children's Society database of families with DHH children. The typically hearing infants were participants in the control condition of a longitudinal randomized controlled trial,[40] in which researchers collected data using the same procedure as the current study. All caregivers gave informed consent for their data to be used for further research. Participation was subject to the following inclusion criteria: infants were term (born no more than 3 weeks before the due date) and with a birth weight >2.5 kg and no other known disabilities or developmental delays. All caregivers had no known physical, mental, or learning disabilities. See Table 1.

Written informed consent was obtained from each caregiver. The Psychology Ethics Committee at the University of Sheffield approved this study.

Procedure

Infant–caregiver dyads were video recorded in free play together for 25 minutes in their home, from 2 different camera angles and without the researcher present.

Coding

Following the coding scheme reported in Donnellan et al,[27] video recordings were coded for infant gestures, vocalizations, gaze to caregiver's face, and recognizable British Sign Language (BSL) signs by using EUDICO Linguistic Annotator software (ELAN)[41] by the first author. Gestures were categorized as either give, show, or index-finger point. All nonvegetative vocalizations (ie, vocalizations containing speech sounds as opposed to coughs, sneezes, hiccups, etc[42,43]) were categorized as either infant vocalization (ie, vocalizations with or without a consonant that were not recognizable words) or words (ie, a recognizable word). Gaze-coordinated vocalizations were automatically identified as any infant vocalization occurring within 1 second of a gaze to the caregiver. Words were orthographically transcribed. BSL signs were translated to English and orthographically transcribed. Because only 2 infants produced signs (2 and 35 signs, respectively), these were not included in statistical analyses. A new coding pass of each video was made for each behavior type (ie, each video was coded 4 times, once each for gestures, vocalizations, gaze, and signs. See Fig 1). Any periods of time in which the infant was not within view of the cameras were identified and not coded. The observable coding time was <25 minutes (but not <21 minutes and 11 seconds) for 4 DHH infants and 6 typically hearing infants. On-screen time was controlled for in analyses.

Reliabilities

Twenty-five percent of video recordings (8 play sessions) were coded for reliability by a second coder. Counts of gestures, infant vocalizations, gaze to caregiver's face, and words were highly correlated (r = 0.99, r = 1.00, r = 0.99, and r = 0.98, respectively). Cohen's κ revealed that

TABLE 1 Characteristics of the DHH Infants

Participant	Sex	Age, mo; d	Left Ear	Right Ear	Age HAs Received, wk	Family Mode of Communication	IMD[a] Decile
1	Male	12; 21	Moderate-severe	Moderate	5	Spoken English	6
3	Male	13; 07	Moderate-severe	Profound	8	Mostly SSE	5
6	Female	12; 25	Profound	Severe	12	Spoken English and occasionally SSE	6
9	Female	12; 30	Severe-profound	Moderate-severe	9	Spoken English and SSE	7
4	Male	19; 09	Moderate	Moderate	6	Spoken English and rarely SSE	6
5	Male	18; 17	Severe	Severe	12	Spoken English	4
7	Male	18; 12	Moderate	Moderate	15	Spoken English	2
8	Male	18; 20	Moderate	Severe	8	Spoken English	7

IMD, Indices of Multiple Deprivation; SSE, sign-supported English.

[a] Areas considered to be within the most deprived 10% of England and Scotland = 1; areas considered to be within the least deprived 10% of England and Scotland = 10.

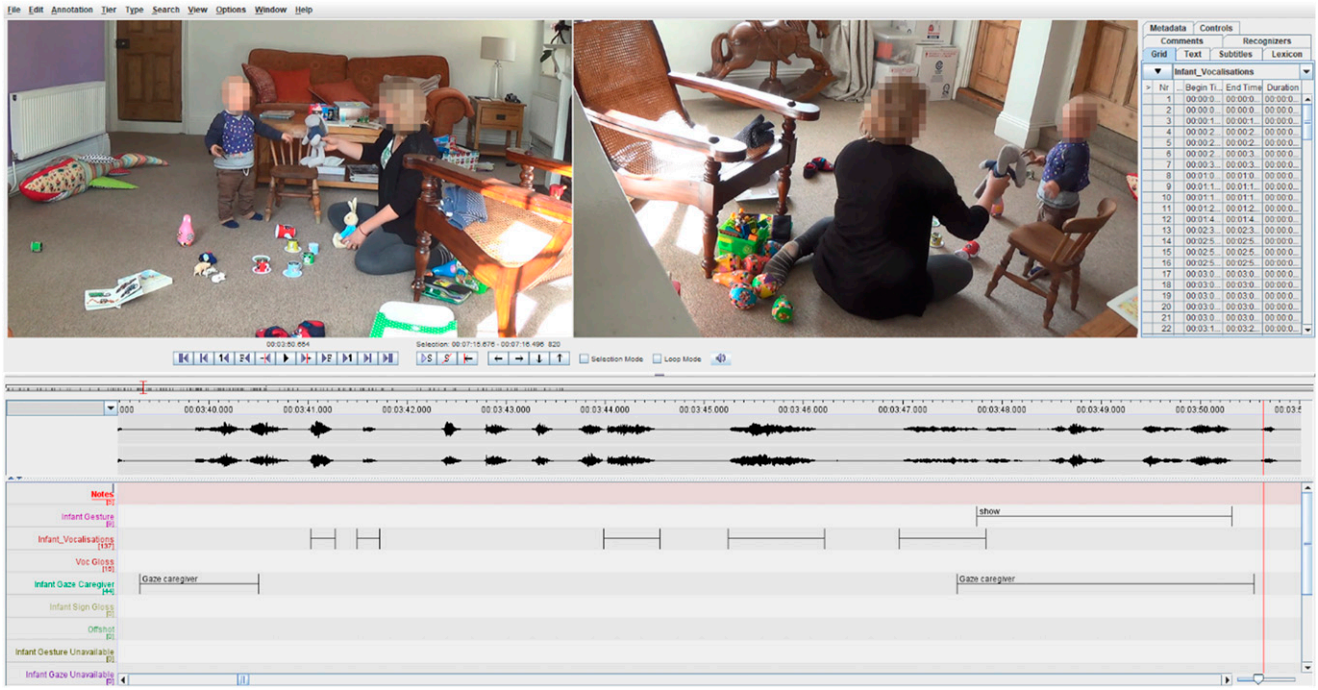

FIGURE 1
Example of video coding in EUDICO Linguistic Annotator software (ELAN).

coders categorized gestures as either gives, shows, or index-finger points with high reliability (k = 0.97; $P < .001$).

Statistical Analysis

To assess whether the DHH infants raised with spoken English as their primary target language differed from typically hearing infants in their production of communicative acts known to predict later spoken language development, we fitted 2 multilevel negative binomial regression models to the data (using lme4 version 1.1–23). This model type was chosen because the outcome variable is a count measure but does not meet the assumption for a Poisson regression (equality of variance and mean). A set of counts for each of the communicative acts (give and show gestures, index-finger pointing, gaze-coordinated vocalizations, and early word use) was entered as the dependent variable, hearing status as a fixed effect (DHH or typical-hearing), participant and age as random effects on the intercept, and communication type as random effects on the intercept and slope. In model 1, we included all prelinguistic acts alongside early word use because this provided the best overall picture of infants' readiness for spoken language. In model 2, given that DHH infants have been observed to show a delay in the onset of spoken word use at 18 months,[21,44] we then restricted the analysis by removing word production from the set of communicative behaviors, thereby focusing on prelinguistic communicative acts. In both models, we included a scaled and centered on-screen time variable as a control because infants varied in how much on-screen coding time they had (4 DHH and 6 typically hearing infants <25 minutes). Whether we included on-screen time in this way or as an exposure offset with a coefficient of 1 did not affect outcomes.

RESULTS

The demographic characteristics of the 8 DHH infants are shown in Table 1. All were born with bilateral permanent hearing loss identified within 3 weeks of birth through newborn hearing screening and received bilateral hearing aids (HAs) by 15 weeks. All were continuing to use bilateral HAs at the time of testing. Hearing loss ranged from moderate (41–70 dB) to profound (>95 dB). Information on specific hearing thresholds (aided or unaided) was not available. Four infants were aged between 12 and 13 months (2 boys), and 4 were aged between 18 and 19 months (all boys). The 8 typically hearing infants were closely matched to the DHH infants for age, sex, and socioeconomic status (determined by using the English and Scottish Indices of Multiple Deprivation: a government measure based on neighborhood income, employment, health provision, and housing). All caregivers were female, typically hearing, and monolingual English-speaking. Four parents were learning BSL to provide sign support for spoken English.

In Table 2, we present descriptive statistics by group for the specific

communicative acts under study. Relative to the typically hearing group, the DHH group produced all communicative acts with a lower median frequency.

Hearing loss had a significant negative effect on the frequency of infant communication (model 1: b = −0.853; 95% confidence interval: −1.515 to −0.192; P = .01). According to model estimates, DHH infants produced 5 fewer communicative behaviors in 25 minutes of play than their matched typically hearing peers. This effect held when the data set was restricted to prelinguistic communicative acts only (model 2 [removing words]: b = −0.770; 95% confidence interval: −1.516 to −0.024; P = .04). According to model estimates, DHH infants produced 4 fewer prelinguistic communicative behaviors in 25 minutes of play than their matched typically hearing peers.

DISCUSSION

We analyzed the early communicative behaviors of infants with moderate-to-profound hearing loss who had no additional needs, who were not preterm or low birth weight, whose parents were hearing, monolingual English speakers, and who had spoken English as their primary target language. These infants were closely matched demographically with typically hearing infants. Fine-grained, naturalistic observation of the specific communicative behaviors that positively predict later spoken language development suggested that hearing loss puts infants at significant risk of delay. Analyses restricted only to prelinguistic communication suggested that the risk extends to those early gestural and vocal communicative developments that pave the way for language. By producing fewer communicative behaviors during interaction, DHH infants are likely to experience fewer learning opportunities, which cumulatively would affect later language learning.

Where do these early gestural and vocal communicative skills come from? Their development is thought to depend on frequent, finely timed interactions between caregiver and infant during earlier stages of development[45–47] (see Mood et al, this supplement). Because both vocal and gestural prelinguistic communication was affected, we assume that reduced communication was not simply the product of reduced imitation of verbal stimuli: this would not explain gestural delay. Rather, communicative tools, including pointing gestures, are likely not being used as frequently by DHH infants because of (1) reduced access to timely caregiver reinforcement of their early communication and (2) reduced access to cues that support joint attention and, thereby, provide insights into how people use gestures and vocalizations to communicate.[48] Hearing parents typically use nonlinguistic vocal cues (eg, gasps and exclamations) to regulate interaction, alert the infant to a topic of interest, initiate joint attention with their infant, and respond to them. These nonlinguistic vocal cues are used alongside gestures. By using sound and gesture in predictable, synchronous ways,[49] hearing parents intuitively make it easier for infants to understand how communicative acts can direct others' attention. However, DHH infants are more likely to miss some of these cues, and, so, early joint attentional episodes are more likely to break down before learning occurs.[33,50,51] Furthermore, hearing parents tend not to use visual cues as frequently or as proficiently in comparison with deaf fluent signing parents, which again places joint attention at risk.[10,34,52] The critical point, here, is that this study strongly suggests that access to sound is important not just for learning spoken language through imitation but for the nonlinguistic uses of sound that hearing parents intuitively use in synchrony with other cues to regulate the back-and-forth of the earliest interactions.

The implications of these findings are that families need support to nurture specific pragmatic developments during the first 2 years of life (namely the appropriate communicative interaction around infant give gestures, show gestures, index-finger pointing, communicative vocalizations, and, eventually, words and signs). A major challenge in this work will be engaging sensitively with parents at what, for many, is an emotionally turbulent time,[53–55] when not all families are ready to participate in interventions or research.

TABLE 2 Descriptive Statistics for Infant Production of Communicative Acts as a Function of Hearing Status

Variable	DHH Group (N = 8)					Typically Hearing Group (N = 8)				
	Mean	SD	Median	Minimum to Maximum	% scoring >0	Mean	SD	Median	Minimum to Maximum	% scoring >0
Give gestures	3.88	4.05	2.50	0–12	75 (n = 6)	9.75	9.59	8.50	0–26	88 (n = 7)
Show gestures	1.13	2.10	0.00	0–6	38 (n = 3)	4.75	5.39	3.50	0–16	75 (n = 6)
Index-finger points	3.00	5.81	0.50	0–17	50 (n = 4)	6.50	8.07	2.00	0–19	63 (n = 5)
Gaze-coordinated vocalizations	15.75	11.31	15.00	6–42	100 (n = 8)	25.00	20.56	19.50	5–61	100 (n = 8)
Word production	6.63	11.56	0.50	0–29	50 (n = 4)	22.00	30.92	1.50	0–74	63 (n = 5)

Descriptive statistics were prorated for the amount of on-screen coding time from a 25 min recording.

In this study, we took the approach of exploring a fine-grained set of behaviors in a hard-to-reach group of infants that was as homogenous as possible (eg, no known language development risk factors other than hearing loss). Although this allowed us to control for potential confounding variables, this had the effect of limiting the sample size and generalizability beyond infants with these characteristics. A complementary approach would be to include a broader range of infants (including those with cochlear implants and those primarily learning to sign) and then control for additional characteristics. Further research will allow us to fully understand the source of the current observed differences with (1) longitudinal studies used to predict DHH child outcomes from both early infant communication and caregiver practice and (2) trials of early intensive intervention to assess how support programs change parenting behaviors and child outcomes. These interventions would need to support all aspects of early communication, including pragmatic aspects of language development.[56]

In sum, the current study used a fine-grained analysis of infant pragmatic development and found DHH infants are at significant risk of delay in precisely the types of early gestural and vocal communication that are important for future language development. The observation that DHH children are at risk for reduced use of gestures from infancy is novel and striking. The implications for health care providers and allied health professionals are clear. By responding to the call to action[57] from the first year of a DHH child's life (ie, screening for risks to infant–caregiver interaction and supporting caregivers to nurture early social communication), there is real potential to lift children onto a positive learning trajectory and open the way to the cumulative learning experiences that build from these early moments.

ABBREVIATIONS

BSL: British Sign Language
DHH: deaf and hard of hearing
HA: hearing aid

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